Project Operating Procedure

Low Stress Groundwater Sampling Procedures

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Annual review of this POP has been performed and the POP still reflects current practice.

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Low Stress Groundwater Sampling Procedures

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Low Stress Groundwater Sampling Procedures

1.0 Project Scope and applicability

This procedure is for the collection of groundwater samples that are indicative of mobile organic and inorganic loads at ambient flow conditions (both the dissolved fraction and the fraction associated with the mobile particulates). The procedure emphasizes the need to minimize stress on the aquifer by using low pumping rates (below 1 liter per minute) and allowing minimal or no drawdown in order to collect samples with minimal alterations to water chemistry. The procedure also reduces the volume of purge water generated, thereby reducing disposal costs A minimum purge volume, based on well screen length and whether the water level is below the top of the screen, is specified so that samples will be representative of the conditions of the groundwater flowing through the well screen.

The procedure is suited for monitoring wells that have a screen, or open interval, of 10 feet or less but is also applicable to wells with longer well screens. The monitoring wells must be sufficiently wide to simultaneously accept a submersible pump or intake tubing from a peristaltic pump, and the probe from an electronic water level indicator. The screened or open interval must be positioned to intercept the existing contaminant plume, and the monitoring well must be properly constructed, developed, and maintained. This procedure does not address the collection of samples from wells containing light or dense non-aqueous phase liquids (LNAPL/DNAPL).

2.0 Health and safety considerations

All calibration, maintenance and servicing of the instrumentation should be performed in a safe area, away from hazardous locations.

Refer to the Site Specific Health and Safety Plan for additional Health and Safety issues.

3.0 Interferences

Contaminants that are known to adsorb to particulates, such as metals, PCBs, etc., will be impacted by elevated turbidity (i.e., >25 NTU). If turbidity below 25 NTU cannot be achieved after redevelopment, the turbidity will be considered part of the total contaminant mobile load, and samples will not be filtered prior to analysis.

ORP is a difficult parameter to measure in the field because the length of time which is necessary for the probe to obtain an accurate measurement is too long to be conducive to use during low-stress monitoring. Consequently, ORP readings may continue to increase or decrease slowly over the purging period.

Gas bubbles present in discharge tubing during purging and sampling are a problem: Their presence indicates off-gassing from groundwater or poor purging connections in the airline or groundwater tubing. Sunlight can exacerbate this problem when low pumping rates are used. Check connections at the surface. If bubbles persist, check connections at the pump. Erect an umbrella to shade and insulate the transparent flow-through cell and tubing to prevent exposure to direct sunlight. During purging and sampling, observe the flow of groundwater in the sample tubing and keep the tubing filled with groundwater, removing all air pockets and bubbles, to the extent possible. Gas bubbles may be reduced by increasing flow, if possible, and keeping tubing and the transparent flow-through cells shaded. Monitor the flow-through cell for trapped gases which can impact the readings. Placing the flow-through cell at a 45 degree angle with the port side facing upwards can help remove air bubbles from the flow-through cell (see Figure 1).

Thermal currents in the monitoring well may cause vertical mixing of water in the well bore. When the air temperature is colder than the groundwater temperature, it can cool the top of the water column. Colder water which is denser than warm water sinks to the bottom of the well and the warmer water at the bottom of the well rises, setting up a convection cell. "During low-flow sampling, the pumped water may be a mixture of convecting water from within the well casing and aquifer water moving inward through the screen. This mixing of water during low-flow sampling can substantially increase equilibration times, can cause false stabilization of indicator parameters, can give false indication of redox state, and can provide biological data that are not representative of the aquifer conditions" (Vroblesky 2007).

Pump tubing lengths above the top of well casing should be kept as short as possible to minimize heating the groundwater in the tubing by exposure to sun light and ambient air temperatures. Heating may cause the groundwater to de-gas, which is unacceptable for the collection of samples for VOC and dissolved gases analyses.

4.0 Equipment and materials

4.1 Submersible pumps, bladder pumps, positive displacement pumps, or peristaltic pump

In selecting the appropriate pump, the sampler must consider the head pressure the pump must overcome (the distance between the water level and the highest point over which the purge water must be raised), the depth to the desired sampling interval, the inner diameter of the inner well casing, the analyses to be performed, and the associated logistics (power source, well accessibility). The pump selected must have sufficient lift capacity for the head pressure anticipated. Peristaltic pumps are effective up to a depth to water of approximately 27 feet (note that this must be measured from the highest point that the water must be raised, such as the top of the outer casing). The pump must be sufficiently small to fit into the well along with the water level indicator. The associated pressure lines, power lines, and purge and intake lines must be sufficiently long to reach to the intended sampling interval. As per EPA guidance, peristaltic pumps or other pumps that use suction shall be avoided for sampling volatile compounds, gases (methane, ethane, ethene), and other parameters that may be impacted by degassing and pH modification. For these analyses, peristaltic pumps must not be used when project decisions hinge on detection of low concentrations of VOCs.

4.2 Bladder Pump

The bladder pump system contains the following components: a pressurized cylinder of inert gas (typically nitrogen), a pump controller, air intake and discharge lines, and bladder pumps. Dedicated bladder pumps installed at some sites, may also have an extension designed to lower the pump intake below the level of the pump. The controller regulates total flow of nitrogen from the pressurized nitrogen cylinder to the pump assembly located in the well. AECOM typically samples one well per nitrogen cylinder. Note that if the bladder pumps are placed at the same depth in each well, multiple wells may be sampled simultaneously with one nitrogen cylinder or air compressor. In this case, a three-way cross splitter with quick-connect air line fittings is attached to the tubing connected to the nitrogen cylinder. Up to three controllers can then be connected to the nitrogen cylinder. If nitrogen cylinders are not available, air compressors may be used to power the bladder pumps.

The tubing bundle connected to the pump has three components: an air line with fittings to the pump and the controller, a sample line, and a Teflon-coated support cable. The sample line, through which the purge water is removed, should be composed entirely of Teflon. In locations where dedicated bladder pumps are installed, the tubing bundle and support cable may be connected to a well plate recessed below the locking cap.

4.3 Peristaltic Pump

Peristaltic pumps are not submerged in the well, but remain outside of the well and function by pulling water to the surface. Use is therefore not approved by EPA Region I for low levels of volatile organic compounds, gases, or other analyses that may be impacted by changes in pressure or pH. A peristaltic pump has a rotating pump head with stepless variable speed that compresses a short stretch of flexible (Pharmed) silicone tubing to pull water up from the well using mechanical peristalsis. The sample water does not come into direct contact with the pump. Teflon tubing is connected to either end of the silicone tubing. The pumps typically used by AECOM, the GeoPump or GeoPump II by GeoTech, operate off an external 12 V battery or 120 V AC power source. Commercially available "JumpStart" 12 volt batteries are typically preferred since electrical hookup is typically not available; since they are safe, easy to carry, and easy to recharge; and since the potential contamination issues associated with use of a generator are avoided.

4.4 Submersible Pump

Submersible pumps used are typically electrical centrifugal pumps. A centrifugal submersible pump consists of impellers or vanes that are spun or rotated by a sealed electric motor. The spinning of the impellers that causes water to be accelerated outward and then upward into the pump's discharge line. The higher the pumping rate, the greater the potential for sample alteration by sample agitation, increased turbulence and pressure changes in the sample. However, maintaining flow in the low-flow range (less than 1,000 mL per minute) is considered acceptable. A centrifugal submersible pump is usually suspended in a monitoring well by a support cable. Electrical submersible pumps typically used by AECOM are the Grundfos Redi-Flo 2, or similar. These are centrifugal pumps constructed of stainless steel and Teflon, and the motors are cooled and lubricated with water rather than with hydrocarbon-based coolants and lubricants that could contaminate groundwater samples. The pumps can achieve flow rates as low as 100 mL per minute. The pumps require a 115 or 230 volt electrical supply, therefore a generator is typically required. Pumps are available for wells 2" in diameter or larger.

4.5 Tubing suited to the pumps and flow-through cells to be used

Teflon or Teflon-lined polyethylene tubing are preferred for all parameters. Stainless steel tubing may be used for sampling organics, but is not recommended for inorganics. PVC, polypropylene or polyethylene may be used for sampling inorganics. Pharmaceutical-grade (e.g. Pharmed) silicon tubing shall be used around the rotor head of the peristaltic pump, and if necessary as a connecting tubing to the flow-through cells. Inner tubing diameter should be kept to the smallest size possible to reduce the generation of air pockets during low flow. Tubing typically used with the peristaltic pumps is Teflon of 1/4-inch outside diameter, and 3/16-inch outside diameter.

4.6 Electronic water level indicator: Solinst Model 101 or similar

Inner casing diameter and pump diameter should be considered in selecting a water level indicator that will fit into the well with the pump. A smaller diameter probe may be required for smaller wells.

4.7 High-Density Polyethylene (HDPE) Y connectors and tubing clamps

These allow for removal of an aliquot of purge water prior to the flow-through cell for turbidity analysis.

4.8 Flow controllers and compressed inert gases for submersible bladder pumps

QED Model MP-10 Flow controller and nitrogen gas are typically used unless nitrogen is an analyte of interest. Portable air compressors may be used in place of compressed gas (e.g., QED Well Wizard).

4.9 Power source

Marine battery, battery pack, compressed gas and flow-controller, or generator and heavy duty extension cords depending on pump

4.9.1 Bladder Pumps

For bladder pump operation, the cylinders of inert compressed gas or portable air compressors function with the flow controller as the power source, although the flow controller does require batteries.

4.9.2 Peristaltic Pumps

The peristaltic pumps typically used by AECOM require an external 12 volt battery or 120 volt AC power source. Commercially available 12 volt batteries designed for jump-starting a car battery ("JumpStart" or similar) are preferred since electrical hookup is typically not available; since they are safe, easy to carry, and easily rechargeable; and since the potential contamination issues associated with use of a generator are avoided.

4.9.3 Submersible Pumps

An external power source is required. If use of a generator is required, precautions must be taken to avoid cross-contamination when handling fuel and when locating the generator to prevent contamination of the samples and sampling equipment by fumes and exhaust.

4.10 Water Quality Meter with Transparent Flow-Through Cell

YSI 6820 Water Quality Meter and transparent Flow-through cell with 610DM data manager, or similar model

4.11 Turbidity Meter

LaMotte 2020 turbidity meter, or similar model

4.12 Other Equipment

- Photoionization Detector (PID)
- Tarp, umbrellas, or other means to shade the tubing, flow-through cells, and water quality meters from direct sunlight
- Graduated cylinders
- Watch with seconds hand
- Graduated plastic purge buckets or carboys
- Well information consisting of well casing diameter, depth to bottom, depth to top and bottom of screened interval, desired depth for sample collection, depth of pump intake (if dedicated pumps are in place) and results of synoptic water level measurements and LNAPL/DNAPL survey.

5.0 Procedures

This section includes the procedures for performing field activities that should be conducted prior to sampling, procedures for purging the wells using the different pumps, and the sampling and post-sampling procedures (which are the same for the different pump types).

5.1 Pre-Sampling Field Activities

Prior to beginning sampling activities in any wells, all synoptic water level measurements and well soundings should be completed in accordance with POP 005 Water Level Measurements.

Wells should be inspected for the presence of DNAPL or LNAPL. Wells with NAPL cannot be sampled using low-flow techniques, and must be sampled with an alternative sampling method, such as bailing.

All non-dedicated down-well measuring devices will be thoroughly decontaminated before sampling and between monitoring locations.

Sampling should begin at the monitoring well likely to have the lowest levels of contamination, generally upgradient or farthest from the site or suspected source, and proceed such that the most contaminated wells are sampled last.

Record the monitoring location identification number. Check the monitoring location for damage or evidence of tampering, and record observations.

Place polyethylene sheeting on the ground and assemble all necessary sampling equipment on top of it. This helps to prevent contamination of the sampling equipment by the soil, reduces wear on the sampling equipment due to dirt, and reduces the likelihood that contaminated purge water will spill into the surface soil.

Unlock the protective outer casing (if present) and remove the outer well cap.

Remove the inner well cap, and measure the well headspace and breathing zone for total organic vapors. If it is windy, stand upwind of the well to conduct measurements. For well headspace, place the intake of the PID approximately two inches below the plane formed by the top of the inner casing. Measure the total volatile organic concentrations in the breathing zone. Record both readings. Use the breathing zone concentrations to determine appropriate health and safety measures in accordance with the site-specific health and safety plan.

5.2 Purging the Wells

The procedure for sampling with bladder pumps is as follows:

Connect all the lines to the pump. If a dedicated bladder pump is in place, the tubing will already be connected to the pump and is likely connected to the well plate.

Carefully lower the pump to the desired sampling depth using the suspension cable. Take care to minimize disturbance and contact with the well walls which could knock rust or other deposits into the standing water. Secure the pump using the suspension cable.

Connect the pump power cable to the power source. Bladder pumps are driven by compressed gas or air through a controller. The controller typically requires batteries. Connect the regulator, pressurized inert gas cylinder or air compressor, flow controller, and pump. If using compressed gas, use a crescent wrench to attach the regulator to the pressurized nitrogen cylinder. Connect the air line from the regulator to the intake valve of the flow controller. Connect the air line from the outflow valve of the flow controller to the airline to the dedicated bladder pump.

Carefully install a flow-through cell on the sonde. Avoid touching the oxygen probe. Connect a purge water discharge line to the flow-through cell of the water quality meter.

Connect the purge water discharge line from the well to the water quality meter using a HDPE Y connector and pinch valve so that an aliquot of purge water can be obtained before the flow-through cell for turbidity measurements. Connect the discharge tubing from the well to the HDPE Y connector fitting using a short piece of Pharmed silicone tubing. Attach a piece of Pharmed silicone tubing to one end of the fitting and close it with a pinch value or check valve unit. Samples for turbidity measurements will be collected by opening this pinch valve. Connect the other end of the Y connector fitting to the lower of the two openings in the flow-through cell using silicon tubing and short pieces of Teflon tubing. Connect a piece of Teflon tubing to the out flow of the flow-through cell to the purge bucket. Use a short piece of silicon tubing at the cell. Be sure to use a piece of Teflon tubing sufficiently long to allow purge water to flow easily into the purge bucket.

Mount the sonde and flow-through cell assembly at a 45 degree angle to allow air bubbles to escape from the cell, and position the sonde such that any groundwater spills will be directed away from the sample.

Slowly open the valve on the regulator attached to the nitrogen cylinder until the pressure gauge reads approximately 60 pounds per square inch (PSI). Adjust the regulator on the flow controller to approximately 10 - 20 PSI.

Re-measure the static water level.

Determine the minimum purge volume required for the well. Samples should only be collected after the required volume has been removed from the well. For screen lengths of ten feet or less, a minimum volume of one saturated screen length plus drawdown volume must be removed. For screen lengths greater than ten feet, a minimum purge volume of three saturated screen lengths plus drawdown volume must be removed.

If the depth to water is less than the depth to the top of the screen, the screen is fully saturated and the minimum purge volume is one saturated screen length plus drawdown volume for screens of ten feet of less or three saturated screen lengths plus drawdown volume for screens greater than ten feet.

If the depth to water is greater than the depth to the top of the screen, calculate the well volume. Subtract the difference between the depth to water and the depth to the top of the screen from the well screen length to obtain the saturated well screen length. Round the saturated well screen length up to the nearest foot, and calculate the well volume using the volume per foot of screen length. Multiply the saturated well screen volume by three if the well screen length is greater than 10 feet.

Record the saturated well screen length and the saturated well screen volume on the sampling worksheet.

Start the flow controller and begin purging at the slowest rate possible.

- Note the purge start time.
- Collect all purge water in a bucket or carboy.
- Slowly increase the pressure at the controlled until discharge begins. The bladder pump controller should be set to allow for adequate recharge such that a maximum flow rate with no drawdown is achieved (generally 100-1,000 mL/min) and a smooth, even discharge flow is achieved. Refer to the historical flow controller settings for the well to select the starting controller pressure and intake and discharge intervals.

- Measure the flow rate using a graduated cylinder and time piece and monitor the water level and pumping rate.

Once drawdown has stopped and an acceptable flow rate established, begin monitoring indicator parameters and continue monitoring flow rate and water level.

- Record reading every three to five minutes, or as appropriate for the flow rate and flow-through cell volume. Use the water quality meter to monitor the following: temperature, pH, specific conductance, DO, and ORP. Use a turbidity meter to monitor turbidity.
- In the event that the well has extremely low recharge such that the lowest purge rate possible (100 mL/min or more, if equipment cannot effectively purge that slowly) continues to dewater the well, do not allow a water level that was above the top of the screen to drop below it, do not allow a water level already below the top of the screen to drop further, do not allow the water level to drop below the pump intake, and do not pump the well dry under any circumstances. Notify the field team leader of the situation. If all efforts to avoid dewatering the well have failed, a decision may be made to allow the well to recharge to a level sufficient to allow for collection of the necessary sample volume and to sample the well immediately. Record detailed notes concerning the sampling of the well.
- Stop purging when all parameters have stabilized. Parameters are considered to have stabilized if, over three consecutive readings, the following criteria are met:
  - pH ± 0.1 unit
  - specific conductance and temperature ± 3%
  - turbidity ± 10% or < 5 NTU
  - DO ± 10% (down to a detection limit of 0.5 mg/L)
  - ORP ± 10 mV
- The reporting limits presented are the lowest concentrations to which the instrument is considered linear and therefore accurate. Three consecutive readings below the reporting limits presented are considered to be stable.
- Readings should be recorded approximately every 5 minutes for flows in the range of 200 to 500 ml/min. Readings should be taken less frequently if the maximum flow rate is less than 100 ml/min because of the retention time in the flow-through cell. Each reading should represent a fresh aliquot of groundwater in the flow-through cell.
- Record the time at which the required minimum volume was removed, and record the total volume removed prior to sampling.
- If parameters do not stabilize, or turbidity remains greater than 5 NTU, or the minimum volume cannot be removed prior to the maximum purging time, contact the field team leader. Technical judgment will be used to ascertain when sampling should be commenced.

5.3 Sampling with Peristaltic Pumps

The procedure for sampling with peristaltic pumps is as follows:

Determine the depth at which the samples will be collected by referring to the Work Plan. Samples are frequently collected from the most-contaminated interval, as determined by previous profiling investigations, or from the lower part of the screened interval, or the midpoint of the saturated screened interval. If possible, keep the pump intake at least two feet above the bottom of the well to minimize mobilization of sediment that may be present at the bottom of the well.

Connect the necessary tubing to the pump, using a Y connector fitting and pinch valve to split the flow prior to the flow-through cell in order to collect an aliquot for turbidity:

- Measure a new section of pharmaceutical-grade, 3/16-inch inner diameter (ID) silicon tubing and attach it to the peristaltic pump head.
- Note that the length of silicon tubing in contact with the sample should be kept to a minimum.
- Measure a new section of 3/16-inch ID Teflon tubing to extend from the depth of the intended sampling location to the intake end of silicon tubing. To do this and avoid contamination of the tubing, it is recommended that a decontaminated water level measurement tape be used to measure the tubing as it is lowered into the well. The water level indicator may be lowered into the well with the tubing, or allowed to run onto the clean plastic on the ground outside of the well. Since the tubing is typically stored on a roll, straightening the tubing as you put it into the well will help avoid catching the tubing on any obstructions in the well, such as the top of the well screen. Once the tubing is lowered to the desired depth, immediately secure the free end of the Teflon tubing to prevent it dropping into the well. Using a piece of silicon tubing, connect the outflow end of the Teflon tubing to the HDPE Y-connector. Then, using several pieces of Teflon tubing, connect the pinch valve and check valve units to one end of the Y-connector (through which samples for turbidity will be collected) and connect the other end of the Y-connector to the intake of the flow-through cell.

Connect the electrical clamps from the pump to the appropriate terminals on the 12 volt battery.

Note that reversing the connections will typically cause the pump to run in reverse, which could push air into the well and should be avoided.

Re-measure and record the static groundwater level after the tubing has been placed in the well, and the water level has been allowed to stabilize again.

Determine the minimum purge volume required for the well. Samples should only be collected after the required volume has been removed from the well. For screen lengths of ten feet or less, a minimum volume of one saturated screen length plus drawdown volume must be removed. For screen lengths greater than ten feet, a minimum purge volume of three saturated screen lengths plus drawdown volume must be removed.

If the depth to water is less than the depth to the top of the screen, the screen is fully saturated and the minimum purge volume is one saturated screen length plus drawdown volume for screens of ten feet of less or three saturated screen lengths plus drawdown volume for screens greater than ten feet.

If the depth to water is greater than the depth to the top of the screen, calculate the well volume. Subtract the difference between the depth to water and the depth to the top of the screen from the well screen length to obtain the saturated well screen length. Round the saturated well screen length up to the nearest foot, and calculate the well volume using the volume per foot of screen length. Multiply the saturated well screen volume by three if the well screen length is greater than 10 feet.

Record the saturated well screen length and the saturated well screen volume on the sampling worksheet.

Commence purging at the slowest possible flow rate and slowly increase the speed until discharge occurs. The pump rate should be set to allow for maximum flow rate (100-1,000 milliliters per minute) with no drawdown. Refer to historical purge information for recharge information. Under no circumstances should the well be pumped dry and once pumping is begun, it should not be interrupted until all sample volume has been collected. Collect all purge water in a bucket or carboy.

Once the stagnant volume in the tubing has been removed (see below for volume equation), drawdown has stopped, and an acceptable flow rate has been established, begin monitoring indicator parameters and continue monitoring flow rate and water level. Record readings every three to five minutes, or as appropriate for the flow rate and flow-through cell volume. Use the water quality meter to monitor the following: temperature, pH, specific conductance, DO, and ORP. Use a turbidity meter to monitor turbidity.

- Tubing radius = r = 0.0104 ft.
- Volume of tubing = r2 x length of tubing = V (in ft3)
- ft3 x 28.316 = liters
- In the event that the well has extremely low recharge such that the lowest purge rate possible (100 mL/min or more, if equipment cannot effectively purge that slowly) continues to dewater the well, do not allow a water level that was above the top of the screen to drop below it,
- Do not allow a water level already below the top of the screen to drop further,
- Do not allow the water level to drop below the pump intake,
- Do not pump the well dry under any circumstances.
- Notify the field team leader of the situation. If all efforts to avoid dewatering the well have failed, a decision may be made to allow the well to recharge to a level sufficient to allow for collection of the necessary sample volume and to sample the well immediately.
- Record detailed notes concerning the sampling of the well.

Stop purging when all parameters have stabilized. Parameters are considered to have stabilized if, over three consecutive readings, the following criteria are met:

- pH ± 0.1 unit
- specific conductance and temperature ± 3%
- turbidity ± 10% or < 5 NTU
- DO ± 10% (down to a detection limit of 0.5 mg/L)
- ORP ± 10 mV

The reporting limits presented are the lowest concentrations to which the instrument is considered linear and therefore accurate. Three consecutive readings below the reporting limits presented are considered to be stable.

Readings should be recorded approximately every 5 minutes for flows in the range of 200 to 500 ml/min. Readings should be taken less frequently if the maximum flow rate is less than 100 ml/min because of the retention time in the flow-through cell. Each reading should represent a fresh aliquot of groundwater in the flow-through cell.

Record the time at which the required minimum volume was removed, and record the total volume removed prior to sampling.

If parameters do not stabilize, or turbidity remains greater than 5 NTU, or the minimum volume cannot be removed prior to the maximum purging time, contact the field team leader. Technical judgment will be used to ascertain when sampling should be commenced.

5.4 Sampling with Submersible Pumps

The procedure for sampling with submersible pumps is as follows:

Prior to placing any equipment in the well, measure and record the static water level as described in the water level measurement Standard operating procedure.

Note the water level in relation to the top of the screen. If the static water level is above the top of the screen, care should be taken to prevent the water level from dropping below the top of the screen.

Determine the depth at which the samples will be collected by referring to the Work Plan. Samples are frequently collected from the most-contaminated interval, as determined by previous profiling investigations, or from the lower part of the screened interval, or the midpoint of the saturated screened interval. If possible, keep the pump intake at least two feet above the bottom of the well to minimize mobilization of sediment that may be present at the bottom of the well.

Connect the pump to the power source. Submersible pumps are driven by an external power source.

If the use of a generator is required, it should be placed downwind of the sampling location to prevent exhaust from impacting the samples.

Care must be taken in handling the generator and gasoline to preclude cross-contamination of the samples and sampling equipment.

At a minimum, samplers must change gloves after handling the fuel or generator prior to sampling.

Carefully lower the pump to the desired sampling depth using the suspension cable. Take care to minimize disturbance and contact with the well walls which could knock rust or other deposits into the standing water.

Secure the pump using the suspension cable, and connect the ground from the pump.

Connect the purge water discharge line to the water quality meter using a splitter and pinch valve so that an aliquot of purge water can be obtained before the flow-through cell for turbidity measurements.

Connect the outflow end of the purge water line to the HDPE Y connector using a short piece of Pharmed silicone tubing if necessary. Attach a piece of Pharmed silicone tubing to one end of the wye and close it with a pinch value or check valve unit.

- Samples for turbidity measurements will be collected by opening this pinch valve.

Connect the other end of the Y connector to the lower of the two openings in the flow-through cell using Teflon tubing and short pieces of Pharmed silicon tubing at the joints.

Connect a piece of Teflon tubing to the out flow of the flow-through cell to the purge bucket. Use a short piece of Pharmed silicon tubing at the joint.

Be sure to use a piece of Teflon tubing sufficiently long to allow purge water to flow easily into the purge bucket.

Re-measure the static water level.

Determine the minimum purge volume required for the well.

Samples should only be collected after the required volume has been removed from the well.

For screen lengths of ten feet or less, a minimum volume of one saturated screen length plus drawdown volume must be removed.

For screen lengths greater than ten feet, a minimum purge volume of three saturated screen lengths plus drawdown volume must be removed.

If the depth to water is less than the depth to the top of the screen, the screen is fully saturated and the minimum purge volume is one saturated screen length plus drawdown volume for screens of ten feet of less or three saturated screen lengths plus drawdown volume for screens greater than ten feet.

If the depth to water is greater than the depth to the top of the screen, calculate the well volume. Subtract the difference between the depth to water and the depth to the top of the screen from the well screen length to obtain the saturated well screen length. Round the saturated well screen length up to the nearest foot, and calculate the well volume using the volume per foot of screen length. Multiply the saturated well screen volume by three if the well screen length is greater than 10 feet.

Record the saturated well screen length and the saturated well screen volume on the sampling worksheet.

Start the pump and begin purging at the slowest rate possible.

- Note the purge start time. Slowly increase the speed until discharge begins.
- The pump should be set to allow for adequate recharge such that a maximum flow rate with no drawdown is achieved (generally 100-1,000 mL/min).
- Refer to the historical flow controller settings for the well to select the starting controller pressure and intake and discharge intervals.

Collect all purge water in a bucket or carboy.

Measure the flow rate using a graduated cylinder and time piece and monitor the water level and pumping rate during purging.

Under no circumstances should purging be interrupted until all sample volume has been collected.

Once drawdown has stopped and an acceptable flow rate established, begin monitoring indicator parameters and continue monitoring flow rate and water level. Record a reading every three to five minutes, or as appropriate for the flow rate and flow-through cell volume. Use the water quality meter to monitor the following: temperature, pH, specific conductance, DO, and ORP. Use a turbidity meter to monitor turbidity.

In the event that the well has extremely low recharge such that the lowest purge rate possible (100 mL/min or more, if equipment cannot effectively purge that slowly) continues to dewater the well, do not allow a water level that was above the top of the screen to drop below it, do not allow a water level already below the top of the screen to drop further, do not allow the water level to drop below the pump intake, and do not pump the well dry under any circumstances. Notify the field team leader of the situation. If all efforts to avoid dewatering the well have failed, a decision may be made to allow the well to recharge to a level sufficient to allow for collection of the necessary sample volume and to sample the well immediately. Record detailed notes concerning the sampling of the well.

Stop purging when all parameters have stabilized. Parameters are considered to have stabilized if, over three consecutive readings, the following criteria are met:

- pH ± 0.1 unit
- specific conductance and temperature ± 3%
- turbidity ± 10% or < 5 NTU
- DO ± 10% (down to a detection limit of 0.5 mg/L)
- ORP ± 10 mV

The reporting limits presented are the lowest concentrations to which the instrument is considered linear and therefore accurate. Three consecutive readings below the reporting limits presented are considered to be stable.

Readings should be recorded approximately every 5 minutes for flows in the range of 200 to 500 ml/min. Readings should be taken less frequently if the maximum flow rate is less than 100 ml/min because of the retention time in the flow-through cell. Each reading should represent a fresh aliquot of groundwater in the flow-through cell.

Record the time at which the required minimum volume was removed, and record the total volume removed prior to sampling.

If parameters do not stabilize, or turbidity remains greater than 5 NTU, or the minimum volume can not be removed prior to the maximum purging time, contact the field team leader. Technical judgment will be used to ascertain when sampling should be commenced.

5.5 Sampling

Once purging has been completed, test for oxidants and sulfides as required for the analyses to be conducted and in accordance with standard operating procedures. Prior to commencing sampling,

- measure and record final water level, temperature, pH, specific conductance, DO, ORP, turbidity, and flow rate.
- disconnect the purge tubing from the flow-through cell, such that sample water will be collected directly from the tubing.

In keeping with convention, samples should be collected in order of decreasing volatility and reactivity so that the most volatile or reactive samples are collected first. The following are general guidelines. More specific information may be presented in the Quality Assurance Project Plan (QAPP).

- Gases (methane/ethane/ethene/hydrogen/CO2)
- Volatile Organic Compounds
- Semivolatile Organic Compounds
- Pesticide/PCBs
- Dioxins

- Metals

During sample collection, allow the water to flow directly into and down the side of the sample container without allowing the tubing to touch the inside of the sample container or lid, in order to minimize aeration and maintain sample integrity.

In some instances the bladder pump controller pumps water out of the sample tubing in a forceful manner, such that the gases and VOC samples may be compromised. If this is the case, the non-VOC samples should be collected first. Once the non-VOC samples are collected, adjust the flow rate on the bladder pump controller so that the water is no longer being pumped out of the sample tubing in a forceful manner, and collect the samples for analysis of gases and VOCs. Document the modification to the procedure, the adjusted flow rate, and all samples collected in this manner on the monitoring well sampling worksheet and/or field logbook.

5.6 Post-Sampling Field Activities

Preserve the samples as per standard operating procedures for preservation. Immediately label the sample containers with the sample collection date and time and place them on ice. Complete the COC forms as soon as possible.

Cease pumping and disassemble the purging and sampling equipment.

Replace the well cap and lock the outer protective casing.

Decontaminate the sampling equipment as per standard operating procedures for decontamination.

Dispose of all purge water as per the site-specific work plan.

6.0 Quality assurance / quality control

The tubing and lines associated with sampling pumps are typically long and awkward to handle, and careful handling is required to prevent introduction of contaminants into the well. It is therefore preferable for set-up and installation of sampling equipment to be performed by a team of at least two people in order to prevent contamination of equipment to be introduced into the well.

Duplicate measurements cannot effectively be taken using the flow-though cell, since two consecutive measurements taken are not measuring the same sample, and flow cannot be interrupted. Water quality parameters obtained should be compared to historical readings, and potential instrument issues should be considered in the event of major differences.

6.1 Pollution Prevention and Waste Management

Purge water volume is kept to a minimum through the use of the low-stress sampling procedures. When available, historical information on sampling rates for each well will be used in an attempt to minimize time spent determining the equilibrium flow rate and thereby minimizing purge water volume.

Lengths of Teflon tubing removed from each roll of tubing will be tracked to maximize use and minimize waste of remaining pieces.

Disposable tubing will be disposed of in accordance with the site-specific sampling and analysis plan.

Purge water will be containerized until purging and sampling activities at the well are completed. Purge water will then be disposed of in accordance with the site-specific sampling and analysis plan

7.0 Data and records management

All documentation will be conducted in accordance with standard documentation procedures.

Groundwater sampling information specific to each well will be recorded on the monitoring well sampling worksheet. An example monitoring well worksheet is included as Attachment 1 of this POP. Activities common to more than one well, samples collected, deviations from the sampling and analysis plan, and any other unusual occurrences will also be documented in the field logbook in accordance with standard documentation procedures.

8.0 Personnel qualifications and training

All field samplers are required to take the 40-hour OSHA health and safety training course and annual 8-hour refresher courses prior to engaging in any field collection activities.

The entire sampling team should read and be familiar with the site Health and Safety Plan, Work Plan, QAPP (and the most recent amendments), and all relevant POPs before going onsite for the sampling event. It is recommended that the field sampling leader attest to the understanding of these site documents and that it is recorded.

Samplers will have a minimum of one-weeks' experience performing low-stress sampling prior to sampling without supervision

9.0 References

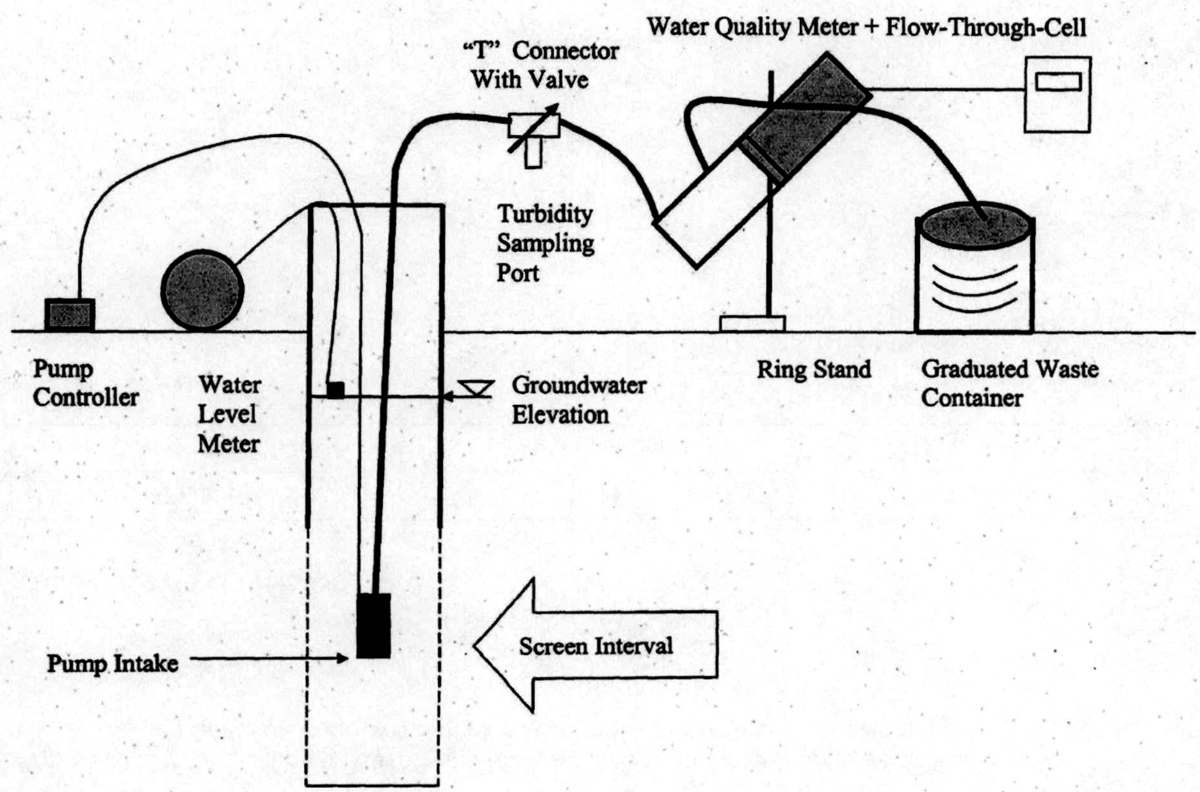
U.S. Environmental Protection Agency, Region 1. *Low-Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells,* Revision 3, January 19, 2010.

Vroblesky, Don A., Clifton C. Casey, and Mark A. Lowery, Summer 2007, *Influence of Dissolved Oxygen Convection on Well Sampling*, Ground Water Monitoring & Remediation 27, no. 3: 49-58.

10.0 Revision History

Revision	Date	Changes
0	September 2010	Original POP

Figure 1: Low-Flow Setup Diagram



Attachment 1: Monitoring Well Sampling Worksheet

Well Purging-Field Water Quality Measurement Form Page 1 of 1

Location (Site/Facility Name):	Southwest Properties						Screen Interval		Top		Bottom
Well #			Date:				From MP in feet:				
Field Personnel:							Pump Intake depth (ft below MP):				
Sampling Organization:	AECOM						Purging Device; (pump type):				
Identify Measuring Point (MP):							Weather:				
Clock Time 24 HR	Depth to Water ft	Pump Dial	Purge Rate ml/min	Cum. Volume Purged gal	Temp. °C	Spec. Conductivity µS/cm²	pH s.u.	ORP mV	DO mg/L	Turb-idity NTU	Comments

Stabilization Criteria:

Temp +/- 3% ORP +/- 10 mv
Spec. Cond +/- 3% DO +/- 10% for values greater than 0.5 mg/L
pH +/- 0.1 SU Turb +/- 10% or <5